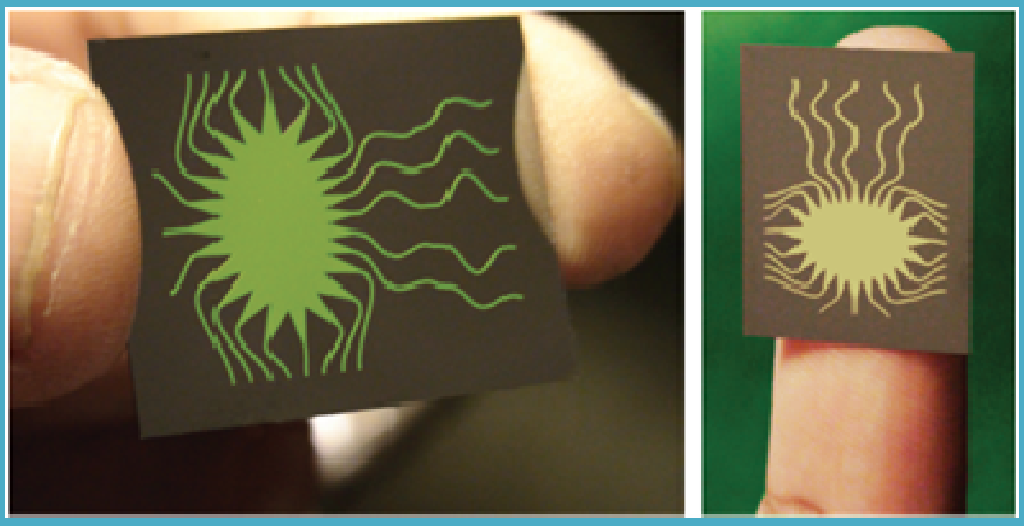
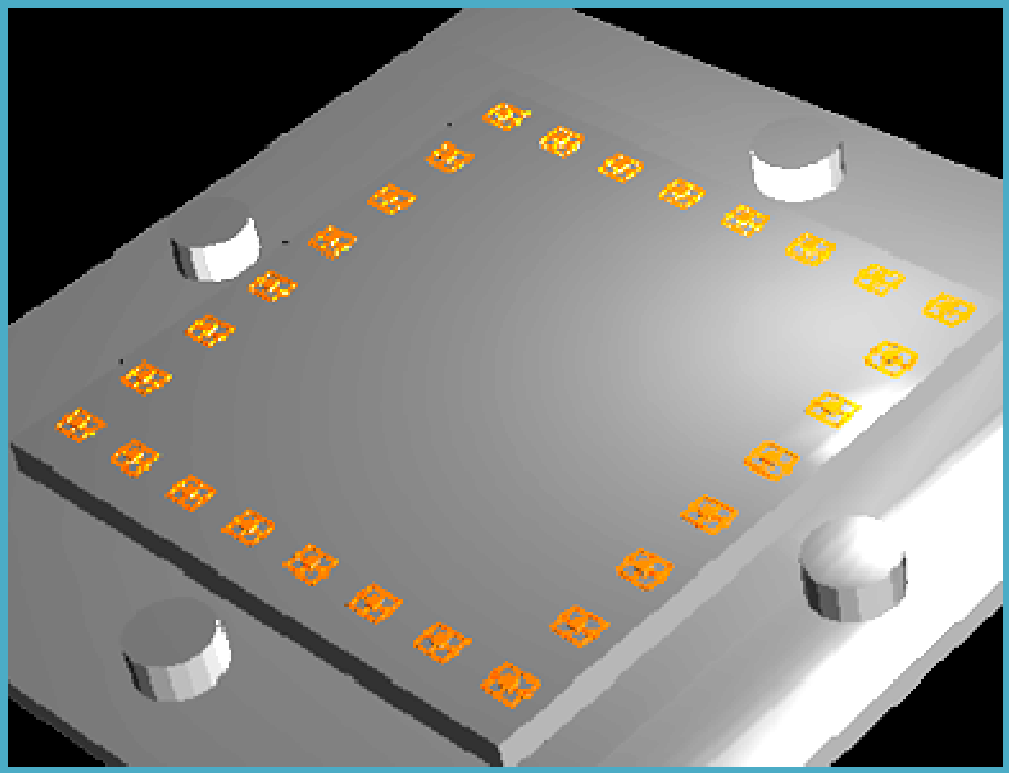
RESEARCH CENTRE FOR INTEGRATED MICROSYSTEMS (RCIM) REPORT

January 1, 2011 – December 31, 2011

Department of Electrical & Computer Engineering
University of Windsor





Director's Report for 2011

I am delighted to present the 2011 annual report of the Research Centre for Integrated Microsystems (RCIM), at the Department of Electrical and Computer Engineering, University of Windsor. RCIM was established in January 2000 to conduct leading edge research, develop collaborative partnerships and train highly qualified graduate students in various areas of integrated Microsystems with applications in the fields of digital signal processing, Computer Vision, automotive electronics. RCIM currently has 11 faculty members, 17 Ph.D. students and 15 M.A.Sc. students who are actively pursuing research in this facility.

In 2011 RCIM faculty members graduated 9 MA.Sc. and 5 Ph.D. students. During the same year, our members received more than $1,004,771 in grants and contracts, and the results from their research works generated 46 papers published in premier Refereed Journals and top tier Refereed Conferences as well as filing two US patents. Also, RCIM members delivered 31 research seminars during 2011 and our members were active in organizing various international conferences including: ISSCS, IEEE-ICECS, and IEEE-MWSCAS few to mention. They have also served on the editorial board of various journals.

Our graduate students won the best paper award at the 2011 IEEE International Conference on Electro/Information Technology and received the second place finish at the 2011 National Competition at CMC Microsystems Annual Symposium held in Ottawa.

On behalf of the RCIM faculty and student members I would like to express our sincere thanks for the continued support we have been receiving from the President, Dr. Alan Wildeman, Provost, Dr. Leo Groarke, Vice-President Research, Dr. Ranjana Bird, and the Dean of Engineering, Dr. Mehrdad Saif of the University of Windsor. The support and encouragement received from Dr. Sid-Ahmed, Head of the Department of Electrical and Computer Engineering is also very much appreciated. Finally, we are thankful to CMC Microsystems for providing RCIM with state-of-the-art facilities allowing us to design advanced integrated Microsystems and for subsidizing our IC fabrication costs.

Majid Ahmadi, PhD, C.Eng., FIET, FIEEE
Director of RCIM
University Professor

I. RCIM Areas of Specialization

The Research Centre for Integrated Microsystems within the Department of Electrical and Computer Engineering in the Faculty of Engineering at the University of Windsor is carrying out leading edge research in the following areas:

1. **MICROELECTRONICS,** including:
    - High Speed DSP Systems
    - Computer Arithmetic
    - Encryption
    - Radio Frequency Identification (RFID)
    - Testing of Mixed Signal Integrated Circuits
    - Field Programmable Chips and Systems
    - CMOS and Nanoelectronic circuits design

2. **MICROELECTROMECHANICAL SYSTEMS (MEMS),** including:
    - Sensors and Filters
    - Capacitive Microphones and 3-D Acoustical Sensing
    - Electromagnetic Microactuators
    - Acousto-Magnetic Transducers
    - Optical Switching MEMS
    - Automotive Sensors
    - Customs MEMS Sockets
    - Micro power Generators
    - Atomic Force Microscopy
    - MEMS RADAR

3. **DIGITAL SIGNAL PROCESSING AND COMMUNICATION,** including:
    - Algorithms
    - Massively Parallel Arrays and Special Architectures
    - Computer Vision and Image Processing
    - Pattern Recognition and Document Analysis
    - Network Security Management
    - Network Management

These projects vary from fundamental pre-competitive research to mission-oriented research, technology transfer and prototype development. We are particularly interested in areas requiring advanced signal processing systems embedded in complex integrated microsystems.

II. RCIM MEMBERS

(A) Faculty Members:

Eleven faculty members in Electrical and Computer Engineering conduct research and supervise graduate students as members of the Research Centre for Integrated Microsystems. The day-to-day operation of the Centre is administered by the coordinator of the RCIM, who provides training for new graduate students on how to use the facilities, as well as maintaining the hardware and CAD tools used by the RCIM members.

1. Dr. Majid Ahmadi, Professor (Director, RCIM)
2. Dr. Shervin Erfani, Professor
3. Dr. Chunhong Chen, Professor
4. Dr. Esam Abdel-Raheem, Associate Professor
5. Dr. Sazzadur Chowdhury, Associate Professor
6. Dr. Roberto Muscedere, Associate Professor
7. Dr. Mohammed Khalid, Associate Professor
8. Dr. Huapeng Wu, Associate Professor
9. Dr. Mitra Mirhassani, Assistant Professor
10. Dr. Rashid Rashidzadeh (Adjunct Professor and RCIM Coordinator)
11. Dr. William C. Miller (RCIM Director Emeritus)

(B) Student Members:

RCIM has a strong track record of training outstanding graduate students. Our students have been very successful in finding employment in academia, industries as well as admissions to PhD programs at major universities.

RCIM Students Graduated in 2011				
First name	**Surname**	**Program**	**Supervisor(s)**	**Thesis**
Mario	Mendizabal	M.A.Sc.	Dr. C. Chen	Low Power Demodulator Design for RFID Applications
Walid Mustafa	Mahmoud	Ph.D.	Dr. H. Wu	Efficient Multiplicative Inverse for Finite Fields
Naila	Syed	M.A.Sc	Dr. C. Chen	A Low Power Multiple Valued Logic SRAM Cell Using Single Electron Devices
Olakunle	Esuruoso	M.A.Sc	Dr. H. Wu	Efficient Implementation of Cryptographic Hashing Functions
Amir Hossein	Nabatchian	Ph.D.	Dr. M. Ahmadi & Dr. E. Abdel-Raheem	Human Face Recognition
Iftekhar	Ibne Basith	M.A.Sc	Dr. M. Ahmadi & Dr. R. Rashidzadeh	A built-in Self-test solution for CMOS-MEMs Sensors
Golnar	Khodabandehloo	Ph.D.	Dr. M. Ahmadi & Dr. Mirhassani	A Prototype CVNS Distributed Neural Network
Mahzad	Azarmehr	Ph.D.	Dr. M. Ahmadi	Arithmetic with Two-Dimensional Logarithmic Number System (2DLNS)
Ismail	Hamieh	M.A.Sc.	Dr. S. Chowdhury	A 77 GHz Reconfigurable Micromachined Microstrip Antenna Array
Soke	Onyemelukwe	M.A.Sc	Dr. S. Erfani	Authentication and Confidentiality in Ad Hoc Network Environment
Tugrul	Zure	M.A.Sc	Dr. S. Chowdhury	Characterization of a Non-Planar CMUT Array
Mohan	Thangarajah	M.A.Sc	Dr. M. Kahlid	A New Simplified Algorithm Suitable for Implementation on FPGA for Turbo Codes
Guoqing	Deng	Ph.D.	Dr. C. Chen	Hybrid SET-MOS Arithmetic Circuits Design
Chia-Chin	Liu	M.A.Sc	Dr. C. Chen	SET-Based Boltzmann Machines for Neural Networks

Current RCIM Students				
First name	**Surname**	**Program**	**Supervisor**	**Thesis**
Iman	Makaremi	Ph.D.	Dr. M. Ahmadi	Face Recognition with Degraded Images
Abbas	Elazhari	M.A.Sc	Dr. M. Ahmadi	Face Recognition from Low Resolution Images
Ali	Attaran	Ph.D.	Dr. S. Chowdhury	A 77 GHz Rotman lens on a High Resistivity Silicon wafer for Automotive Radars
Jonathan	Hernandez	M.A.Sc	Dr. S. Chowdhury	A BCB based CMUT design
Sabrina	Zereen	M.A.Sc	Dr. S. Chowdhury	An FGPA based Algorithm for a tri-mode automotive radar
Jared	Jacques	M.A.Sc	Dr. S. Chowdhury	Investigation of a MEMS radar based Microwave probe for breast cancer detection
Faroq	Awin	Ph.D.	Dr. M. Ahmadi & Dr. E. Abdel Raheem	Improving the Performance of Spectrum Sensing for Cognitive Radio using Cyclostationary Features
Salem	Alsaid	Ph.D	Dr. H. Wu	Efficient Finite Field Multiplication
Wangchen	Dai	M.A.Sc.	Dr. H. Wu	Efficient Cryptographic Computation
Iftekhar	Ibne Basith	Ph.D	Dr. M. Ahmadi & Dr. R. Rashidzadeh	A built-in Self-test solution for 3D integrated systems
Suhas	Sreehari	M.A.Sc.	Dr. M. Ahmadi & Dr. H. Wu	Fast Modular Reduction for Large Integer Multiplication
Shruti	Kubatur	M.A.Sc.	Dr. M. Ahmadi & Dr. Sid-Ahmed	Handwritten Devanegari Word Recognition
Ayesa	Parvin	M.A.Sc.	Dr. M. Ahmadi & Dr. R. Muscedere	Design and Application of Neural Networks with CSD Coefficients for Human Face Recognition
Karl	Leboeuf	Ph.D.	Dr. M. Ahmadi & Dr. Muscedere	GPU and ASIC acceleration of Elliptic Curve Cryptography
Soodeh	Nikan	Ph.D.	Dr. M. Ahmadi	Human Face Recognition under Occlusion
Shoaleh	Hashemi-Namin	Ph.D.	Dr. M. Ahmadi & Dr. H.Wu	Low-Power Arithmetic over Finite Field
Nabeeh	Kandalaft	Ph.D.	Dr. M. Ahmadi & Dr. R. Rashidzadeh	MEMS Test Interface Module
Muhammad	Supon	M.A.Sc.	Dr. M. Ahmadi & Dr. R. Rashidzadeh	A PLL Based Readout and BIST for MEMS Sensors
Mahnaz	Shafii	Ph.D.	Dr. M. Ahmadi & Dr. Sid-Ahmed	On-line Persian Word Recognition

Current RCIM Students				
First name	**Surname**	**Program**	**Supervisor**	**Thesis**
Amar	Sawadi	M.A.Sc.	Dr. S. Erfani & Dr. R. Rashidzadeh	A High Gain Scanning Patch Antenna for RFID
Krishnamohan	Thangrajah	Ph.D.	Dr. S. Erfani & Dr. R. Rashidzadeh	Indoor Location Positioning using Wireless Systems
Ishaq	Gul Muhammad	Ph.D.	Dr. E. Abdel-Raheem & Dr. K. Tepe	Efficient Channel Equalization Algorithms for Multicarrier Communication Systems
Nabih	Jaber	Ph.D.	Dr. E. Abdel-Raheem & Dr. K. Tepe	Towards More Reliable MAC and PHY Layer Designs for High QoS Achievements for Safety Messaging in DSRC Systems
Ajit	Muhury	M.A.Sc.	Dr. C. Chen	TBA
Salem	Abdullah	Ph.D	Dr. H. Wu	TBA
Yiruo	He	M.A.Sc.	Dr. H. Wu	Efficient Modular Exponentiation with resistance to Side Channel Attacks
Babak	Zamanlooy	Ph.D.	Dr. M. Mirhanssani	A prototype CVNS neural network
Ashley	Novak	M.A.Sc.	Dr. M. Mirhanssani	Immunity against Side Channel Attacks
Farinoush	Saffar	Ph.D.	Dr. M. Mirhanssani & Dr. M. Ahmadi	Programmable Neural Networks for General Pattern Classification Applications
Soheil	Servati	Ph.D.	Dr. R. Muscedere	Hardware Acceleration of Text Display
Leila	Sepahi	M.A.Sc.	Dr. R. Muscedere	Improved MDLNS Number System Addition and Subtraction by Use of Novel Co-Transformation
Daniel	MacDonald	M.A.Sc.	Dr. R. Muscedere	A hardware based image file decoder

Graduate Student Summary

Currently, RCIM faculty members are supervising 15 M.A.Sc. students and 17 Doctoral candidates. Over 70% of RCIM graduate students were recipients of various scholarships from NSERC, OGS, and the University of Windsor.

III. PROFESSIONAL ACTIVITIES of RCIM FACULTY MEMBERS

Dr. M. Ahmadi:

- Member of IEEE-CAS Society Neural Network Committee
- Regional Editor, Journal of Circuits, Systems and Computer
- Associate Editor for Pattern Recognition Journal
- Member of the Steering Committee for the IEEE Midwest Symposium on Circuits and Systems
- Technical Program Chair for the 2011 International Symposium on Signals, Circuits and Systems, Iasi, Romania, 2011.
- Member of the Technical Program Committee for the 2011 Midwest Symposium on Circuits and Systems, Seoul, Korea, August 2011.
- Member of the International Advisory Board for 2012 IEEE-NEWCAS
- Member of the Evaluation Committee for the IEEE Circuits and Systems Society for Mac Van Valkenberg Award, 2012.
- Regional Editor for Journal of Circuits, Systems and Computers
- Associate Editor for Pattern Recognition Journals
- Ph.D. external examiner for Concordia University
- Reviewer for NSERC

Dr. M. Khalid:

- Reviewer for ACM Transactions on Reconfigurable Technology and Systems
- Reviewer for IEEE Trans. on CAD, IEEE Trans. On VLSI and several IEEE sponsored conferences
- Reviewer for Journal of Circuits, Systems and Computers, published by World Scientific
- Reviewer for Canada Foundation for Innovation (CFI)
- Reviewer for Natural Sciences and Engineering Research Council (NSERC)
- Reviewer for Research Grants Council of Hong Kong

Dr. E. Abdel-Raheem:

- Editorial Board Member, IET (formerly IEE) Signal Processing,
- Associate Editor, Canadian J. Elec. & Comp. Eng. (CJECE)

Dr. S. Chowdhury:

- Reviewer, Elsevier, Communications in Nonlinear Science and Numerical Simulations
- Reviewer, IEEE Sensors Journal
- Reviewer, IEEE Transactions on Circuits and Systems I
- Reviewer, Journal of Nanotechnology, Institute of Physics Publishing, Dirac House, Temple Back, Bristol, UK
- Reviewer, Journal of Physics D: Applied Physics, Institute of Physics Publishing, Dirac House, Temple Back, Bristol, UK
- Reviewer, Journal of Micromechanics and Microengineering, Institute of Physics Publishing, Dirac House, Temple Back, Bristol, UK

Dr. S. Erfani:

- Member of Steering Committee, IEEE Midwest Symposium on Circuits and Systems
- Technical Advisory Board member, Journal of Network and Systems Management

Dr. R. Rashidzadeh:

- Reviewer for IEEE Transactions on Computers
- Reviewer for IEEE transaction on Instrumentation and Measurement
- Reviewer for Journal of Analog Integrated Circuits and Signal Processing
- Reviewer for Journal of Electromagnetic Waves and Applications (JEMWA)

IV. SCHOLARY ACTIVITIES AND PUBLICATIONS

(a) Refereed Journal Publications

- S. Y. Wong, C. Chen, and Q. M. J. Wu, "Low Power Chien Search for BCH Decoder Using RT-Level Power Management," IEEE Transactions on Very Large Scale Integration (VLSI) Systems, vol. 19, no. 2, February 2011, pp. 338-341.

- C. Chen, "Delay Estimation on Single-Electron Tunneling Based Logic Gates," IEEE Transactions on Nanotechnology, vol. 10, no. 6, November 2011, pp. 1254-1263.

- Hosseinzadeh Namin, H.Wu, M.Ahmadi "High –Speed Architectures for Multiplication Using Reordered Normal Basis" IEEE Transactions on Computers (Accepted).

- G. Khodabandehloo, M. Mirhassani, M.Ahmadi "Analog Implementation of a Novel Resistive Type Sigmoidal Neuron" IEEE Trans. On Very Large Scale Integration (Accepted).

- G. Khodabandehloo, M. Mirhassani, M.Ahmadi "CVNS-Based Storage and Refreshing Scheme for a Multi-Valued Dynamic Memory" IEEE Transactions on Very Large Scale Integration (VLSI) Systems, Vol. 19, No. 8, August 2011, pp1517-1521.

- Hosseinzadeh Namin, H. Wu, M.Ahmadi "A word-Level Finite Field Multiplier Using Normal Basis" IEEE Trans. On Computers, Vol. 60 Issue 6, 2011, pp890-895.

- Baradarani, Q.M.J. Wu, M.Ahmadi, P. Mendapara "Tunable Halfband-Pair wavelet Filter Bank and Application to Multifocus Image Fusion" Pattern Recognition Journal (Accepted).

- Iman Makaremi, Majid Ahmadi "Wavelet Domain Blur Invariants for Image Analysis" Accepted for publication in IEEE Trans. On Image Processing. Date of acceptance Aug. 24, 2011.

- G. Khodabandehloo, M. Mitramirhassani, M. Ahmadi "A Prototype CVNS Distributed Neural Network Using Synapse-Neuron Modules" accepted for publication in IEEE Transactions on Circuits and Systems I, paper ID: 10733, 9 pages, 2011.

- Hosseinzadeh-Namin, H. Wu, M.Ahmadi "Efficient Word Level Multiplier in Finite Field Using Redundant Representation," ACM Transactions on Embedded Computing Systems (Accepted).

- M. Azarmehr, R. Rashidzadeh, M. Ahmadi "Low-Power Oscillator for Passive RFID Transponder" accepted for publication in IET Journal of Circuits, Devices and Systems, 12 manuscript pages (Accepted).

- T. M. Supon, R. Rashidzadeh, M. Ahmadi "A Readout and BIST Solution for MEMS Sensors" accepted for publication in journal of Circuits, Systems and Computers (Accepted).

- M. Azarmehr, M.Ahmadi "Low-Power Finite Impulse Response (FIR) Filter Design Using Two-Dimensional Logarithmic Number System (2DLNS) Representations," Journal of Circuits, Systems and Signal Processing (Accepted).

- M. J. Islam, S. M. Basalameh, M. Ahmadi, M. A. Sid-Ahmed: Computer Vision-Based Quality Inspection System of Transparent Gelatine Capsules in Pharmaceutical Applications "Americal Journal of Intelligent (Accepted).

- M. Rahman, S. Chowdhury, "Square Diaphragm CMUT Capacitance Calculation using a New Deflection Shape Function", *Journal of Sensors,* (Accepted).

- Mirhassani, Mitra; Ahmadi, Majid; Jullien, Graham, A., Accuracy of representing analog values by continuous valued number system, Journal of Circuits, Systems and Computers, No. 20, Vol. 8, pp.1449-1476, 2011

- N. Jaber, K. Tepe, and E. Abdel-Raheem, Performance Enhancement of the DSRC System using Frequency-Domain Equalization, Int. Journal of Electronics & Communications (AEÜ), Elsevier, vol. 19, (5), pp. 1294-1317, May 2011.

- S. Erfani and N. Bayan, Characterization of nonlinear and linear time-varying systems by Laplace transformation, International Journal of systems Science, pp. 1-18, (to appear), prepublication online http://dx.doi.org/00207721.2012.659689, march 14, 2012.

- Nabih Jaber, Kemal Tepe, and Esam Abdel-Raheem, "Reconfigurable Simulator using Graphical User Interface (GUI) and Object Oriented Design for OFDM Systems", Int. Journal of Simulation Modeling Practice and Theory, Elsevier, vol. 65, (11), pp. 924-928, Nov. 2010.

- I.G. Muhammad, E. Abdel-Raheem, and K. Tepe, Blind Adaptive Low-Complexity Time-Domain Equalizer Algorithms for ADSL Systems by Adjacent Lag Auto-correlation Minimization (ALAM), Digital Signal Processing, Elsevier (Accepted).

(b) Refereed Conference papers

- M.J. Islam, S. Basalamah, M. Ahmadi, M.A. Sid-Ahmed "Capsule Image Segmentation in Pharmaceutical Applications Using Edge-Based Techniques" Proc. Of IEEE EIT'2011, IEEE Electro/Information Technology, University of Minnesota, Mankato, USA, May 2011.(Winner of the best paper Award)

- El-Feghi, A. Tahar, M. Ahmadi "Efficient Feature Extraction for Fingerprint Classification with Multi-Layer Perceptron Neural Network" Proceedings of 2011 International Symposium on Signals, Circuits and Systems, June30- July 1, 2011, Iasi, Romania, pp157-160.

- S. Erfani, M. Ahmadi, " Fundamentals of Generalized Laplace Transform Techniques for Linear Time- Varying Systems" Proceedings of 2011 International Symposium on Signals, Circuits and Systems, June30- July 1, 2011, Iasi, Romania, pp253-256.

- M. Azarmehr, M.Ahmadi, G.A. Jullien "A Two- Dimensional Logarithmic Number System (2DLNS)-based Finite Impluse Response (FIR) Filter Design" Proceedings of 9th IEEE NEWCAS Conference, June 26-29, 2011, Bordeaux, France, pp37-40.

- N. Kandalaft, R. Rashidzadeh, M.Ahmadi "A Signal Integrity Enhancement Technique for High Speed Test Systems" Proc. Of 2011 Canadian Conference on Electrical and Computer Engineering, May 2011, Niagara Falls, Canada, pp 1300-1303.

- Makaremi, K. Leboeuf, M. Ahmadi "Wavelet Domain Blur Invariants for 1D Discrete Signals" Proc. Of 2011 ICIAR, June 2011, Vancouver, Canada, pp 69-79.

- T.M. Supon, K. Thangarajah, R. Rashidzadeh, M.Ahmadi "A PLL Based Readout and Built-in Self-Test for MEMS Sensors" Proc. Of 2011 IEEE Midwest Symposium on Circuits and Systems, August 7-10, Seoul, Korea, pp TP2G-5.

- K. Leboeuf, R. Muscedere, M.Ahmadi “Performance Analysis of Table-Based Approximations of Hyperbolic Tangent Activation Function” Proc. Of 2011 IEEE Midwest Symposium on Circuits and Systems, August 7-10, Seoul, Korea, pp.TP1T3-1.

- S. Erfani, M.Ahmadi, N. Bayan “On Properties of Double Laplace Transformation for Analysis of Linear Time Varying Systems” Proc. Of 2011 IEEE Midwest Symposium on Circuits and Systems, August 7-10, Seoul, Korea, pp. TP1T3-2.

- B. ElKarami, M.Ahmadi “An Efficient Design of 2-D FIR Digital Filters By Using Singular Value Decomposition and Genetic Algorithm with Canonical Signed Digit (CSD) Coefficients” Proc. Of 2011 IEEE Midwest Symposium on Circuits and Systems, August 7-10, Seoul, Korea, pp. WP1C-2.

- G. Khodabandehloo, M. Mirhassani, M. Ahmadi “A Study of Resistive-Type Truncated CVNS Distributed Neural Networks” Proc. Of 2011 IEEE International Symp. On Circuits and Systems, May 15-18, 2011, Rio de Janeiro, Brazil, pp 2685-2688

- K. Leboeuf, I. Makaremi, R. Muscedere, M.Ahmadi “Image Processing Technique for Segmenting Microstructural Porosity of Laser-Welded Thermoplastics” 2011 IEEE International Conference on Electronics circuits and Systems, December 2011, Beirut, Lebanon, pp760-763.

- I.I. Basith, T. Supon, A. Muhury, R. Rashidzadeh, M.Ahmadi “Performance Enhancement of Single Electron Junction 1-Bit Full Adder”Proc. of 2011 IEEE International Conference on Electronics circuits and Systems, December 2011, Beirut, Lebanon, pp157-160.

- H. Schmidt, S. Chowdhury, “MEMS Based Radar Sensor for Automotive Application”, Proceedings of TechConnect Summit, 2011, June, Boston, June 12-14, 2011, pp. 1-2.

- S. Lal, S. Chowdhury, “An FPGA-Based 77 GHz MEMS Radar Signal Processing System for Automotive Collision Avoidance”, Proceedings of CCECE 2011, Niagara falls, May 8-11, 2011, pp-1351-1356.

- S. Lal, R. Muscedere, S. Chowdhury, “An FPGA-Based Signal Processing System for a 77 GHz MEMS Tri-Mode Automotive Radar”, Proceedings of IEEE Symposium on Rapid system Prototyping (RSP2011), Karlsruhe, Germany, May 24-27, 2011, pp. 2-8.

- G. Deng and C. Chen, “A Hybrid CMOS-SET Multiplier Using Frequency Modulation,” In Proceedings of 2011 IEEE International Conference on Nanotechnology (IEEE-Nano'11), August 2011, Portland, Oregon, USA, pp. 1167-1170.

- C. Liu and C. Chen, “SET Based Boltzmann Machine and Hopfield Neural Networks,” In Proceedings of 2011 IEEE International Conference on Nanotechnology (IEEE-Nano'11), August 2011, Portland, Oregon, USA, pp. 413-416.

- N. Syed and C. Chen, “Low Power SET-Based SRAM Cell Design Using Negative Differential Conductance,” In Proceedings of 2011 IEEE International Conference on Nanotechnology (IEEE-Nano'11), August 2011, Portland, Oregon, USA, pp. 744-747.

- Thangarajah, Mohan; Sharrava, Behnam; Khalid, Mohammed, A. S., "A Novel Simplified Log-MAP Algorithm Suitable for Hardware Implementation of Turbo Decoding", Proc. of Canadian Conference on Electrical and Computer Engineering, 2011, May.

- N. Jaber, K. Tepe, and E. Abdel-Raheem, "Improved Performance at High Code Rates of DSRC PHY Systems using a Linear Demapper", IEEE CCECE, Niagara Falls, May 2011.

- N. Jaber, K. Atiqur Rahman, E. Abdel-Raheem, and K. Tepe, "A quantitative analysis of improved DSRC system using repetition based broadcast safety messaging with hidden terminals", Proc. IEEE IWCMC 2011 Vehicular Communications Symposium, Turkey, pp. 1772 - 1777, August 2011.

- Bharkhada, Prash; Muscedere, Roberto; Wu, Huapeng, "Truncation Scheme for Recursive Multipliers", 1-4, 2011, May, 2011 International Conference on Computer and Management (CAMAN).

- He, Yiruo; Wu, Huapeng, "Efficient architectures for modular exponentiation using Montgomery powering ladder", 1202-1205, 2011, CCECE 2011.

- S. Erfani and M. Ahmadi, "Fundamentals of generalized Laplace transform techniques for linear time-varying systems," Proc. IEEE Int. Sympo. Sig. Cir. Sys. (ISSCS2011), Iasi, Romania, June 30-July 1, 2011.

- S. Erfani, M. Ahmadi and N. Bayan, "On properties of double Laplace transformation for analysis of linear time-varying systems," Proc. 54th IEEE Int. Midwest Sympo. Cir. Sys (MWSCAS 2011), Seoul, Korea, Aug. 7-10, 2011.

(c) Papers Presented at Special Workshops and Symposia

- Attaran, S. Chowdhury, "A 77 GHz Micromachined Rotman Lens for an Automotive Radar", CMC Microsystems' Annual Symposium 2011, Gatineau, Québec, October 19-20, 2011 (Poster).

- Hamieh, S. Chowdhury, "A 77 GHz Reconfigurable Micromachined Microstrip Antenna Array", CMC Microsystems' Annual Symposium 2011, Gatineau, Québec, October 19-20, 2011 (Poster).

(d) Patents Registered and Applied for

- Dr. S. Chowdhury: MEMS Radar for ranging and velocity measurement (US provisional patent)

- Dr. R. Rashidzadeh, Mr. Nabeeh Kandalaft and Dr. Ahmadi: A MEMS Based Device Interface Module (Canada, U.S. Patent Serial No. 61/457404)

V. LIST OF SEMINARS HELD IN 2011

- **Human Face Recognition**
  Presented by: Amirhosein Nabatchian
  Jan. 21, 2011

- **Design and Implementation of CVNS Based Artificial Neural Networks with On-Chip Learning capability in CMOS and CMOL**
  Presented by: Babak Zamanlooy
  Jan. 28, 2011

- **An Ultra Low Power Oscillator for Passive RFID Transponders**
  Presented by: Mahzad Azarmehr
  Feb. 11, 2011

- **A Built-in Self Test for Capacitive MEMS Devices**
  Presented by: Iftekhar Ibne Basith
  Feb. 18, 2011

- **High Speed Test Interface Module Using MEMS Technology**
  Presented by: Nabeeh Kandalaft
  Mar. 11, 2011

- **A High Gain Scanning Patch Antenna for RFID Passive Tags Operating at 5.8 GHz frequency**
  Presented by: Amar Sawadi
  Mar. 18, 2011

- **A Prototype CVNS Distributed Neural Network**
  Presented by: Golnar Khodabandehloo
  Mar. 25, 2011

- **Characterization of a Non-Planar CMUT Array**
  Presented by: Tugrul Zure
  Apr. 01, 2011

- **A 77 GHz Reconfigurable Micromachined Microstrip Antenna Array**
  Presented by: Ismail Hamieh
  Apr. 08, 2011

- **A Built-in Self-Test Solution for CMOS-MEMs Sensors**
  Presented by: Iftekhar Ibne Basith
  Apr. 15, 2011

- **Wavelet Domain Blur Invariants for Image Analysis**
  Presented by: Iman Makaremi
  Apr. 29, 2011

- **Power consumption comparison of polynomial basis multiplier architectures**
  Presented by: Shoaleh Hashemi Namin
  May 13, 2011

- **Mixed-Signal CVNS-Based Multiplier for Hardware Implementation of Artificial Neural Networks**
  Presented by: Babak Zamanloo
  June 03, 2011

- **Effective Presentation Techniques**
  Presented by: Dr. Majid Ahmadi
  Jan. 21, 2011

- **On Properties of Double Laplace Transformation for Analysis of Linear Time-Varying Systems**
  Presented by: Dr. Shervin Erfani
  June 10, 2011

- **A Many-Core Algorithm for Finite Field Arithmetic Using Normal Basis**
  Presented by: Karl Leboeuf
  July 08, 2011

- **Devanāgarī Handwritten Script Recognition**
  Presented by: Shruthi Kubatur
  July 15, 2011

- **Building Blocks for Designing a High Resolution, Low Power Multiplying DAC**
  Presented by: Ashley Novak
  July 15, 2011

- **Online Persian handwritten Recognition**
  Presented by: Dr. Maher Sid-Ahmed
  July 22, 2011

- **A PLL Based Built-in Self-test for MEMS Sensors**
  Presented by: Tareq Muhammad Supon
  July 29, 2011

- **Guide to Preparing a Conference Poster**
  Presented by: Karl Leboeuf
  Aug. 05, 2011

- **An overview of Human Face Recognition**
  Presented by: Soodeh Nikan
  Aug. 05, 2011

- **How to lose an award winning paper**
  Presented by: Dr. Majid Ahmadi
  Aug. 19, 2011

- **Arithmetic with the Two-Dimensional Logarithmic Number System (2DLNS)**
  Presented by: Mahzad Azarmehr
  Sept. 23, 2011

- **Design of Large Integer Multiplier**
  Presented by: Suhas Sreehari
  Sept. 30, 2011

- **Face Recognition with Degraded Images**
  Presented by: Iman Makaremi
  Oct. 07, 2011

- **Performance Enhancement of Single Electron Junction 1-bit Full Adder**
  Presented by: Iftekhar Ibne Basith
  Oct. 14, 2011

- **Image Processing Technique for Segmenting Microstructural Porosity of Laser-Welded Thermoplastics**
  Presented by: Karl Leboeuf
  Oct. 21, 2011

- **Implementation of Addition and Subtraction with Novel Co-transformation for MDLNS Number System**
  Presented by: Leila Sepahi
  Nov. 11, 2011

- **Hardware JPEG Decompression**
  Presented by: Daniel MacDonald
  Nov. 25, 2011

- **Subspace Tracking Via Geometric Analysis**
  Presented by: Dr. Cheng Zhu
  Dec. 02, 2011

VI. AWARDS AND HONOURS

- Best paper award from the IEEE International Electro/Information Technology 2011 Conference for the paper entitled “Capsule Image Segmentation in Pharmaceutical Applications Using Edge-Based Techniques” by M.J. Islam, S. Basalamah, M.Ahmadi, M.A. Sid –Ahmed.

- Ali Attaran, a PhD student supervised by Dr. Chowdhury won the second place in national competition during CMC Microsystems annual symposium in Gatineau in October, 2011

VII. GRANTS AND CONTRACTS RECEIVED BY THE RCIM MEMBERS

1. Dr. M. Ahmadi, NSERC Discovery Grant, $58,471 per year.
2. Dr. M.Ahmadi, Research Stipend from the University of Windsor, $10000 per year.
3. Dr. M. Ahmadi, Research support from VP-R for fabrication of a MEMS Chip,$4500.
4. Dr. C. Chen, NSERC Discovery Grant $20,000
5. Dr. C. Chen, AUTO21, $17,000

6. Dr. S. Erfani, University of Windsor Research Development $10,000
7. Dr. R. Muscedere, NSERC Discovery Grant $20,000
8. Dr. M. Khalid, NSERC Discovery Grant $20,000
9. Dr. M. Mirhassani, NSERC Discovery Grant $19,000 per year
10. Dr. M. Mirhassani, AUTO21, $18,270
11. Dr. R. Rashidzadeh, University of Windsor Research Development $10,000
12. Dr. S. Chowdhury, NSERC Discovery Grant $20,000/year LOI accepted for Auto21 500 series application and final proposal has been submitted
13. Dr. S. Chowdhury, MEMS-Based Intelligent Active Safety Systems, Auto21, $70,700/year
14. Dr. Huapeng Wu, NSERC Discovery Grant $20,000
15. ECE internal research grant for RCIM faculty members $140,000
16. In-Kind support of $210,030 per year from IntellliSense Software Inc. towards the license of their MEMS CAD tools
17. CMC Microsystems contributions to RCIM totaled $337,500 for 2011.

Total Grants received by RCIM members in 2011: $1,004,771

VIII. GRADUATE COURSES TAUGHT BY RCIM MEMBERS

1.	Dr. S. Erfani	06-88-557: Network Security
2.	Dr. S. Erfani	06-88-523: System Theory
3.	Dr. M. Ahmadi	06-88-521 Digital Signal Processing
4.	Dr. M. Ahmadi	06-88-590 Motion Estimation
5.	Dr. E. Abdel-Raheem	06-88-551: Advanced Digital Signal Processing
6.	Dr. E. Abdel-Raheem	88-562: VLSI Implementation of DSP Systems
7.	Dr. M. Khalid	06-88-560: Reconfigurable Computing
8.	Dr. M. Khalid	06-88-590: Physical Design Automation for VLSI and FPGAs
9.	Dr. R. Muscedere	06-88-531: VLSI Design
10.	Dr. C. Chen	06-88-541: Low Power CMOS Design
11.	Dr. C. Chen	06-88-590-43: Introduction to Nanoelectronic Design
12.	Dr. H. Wu	06-88-555: Computer Arithmetic
13.	Dr. H. Wu	06-88-529: Discrete Transforms & Number Theoretical
14.	Dr. S. Chowdhury	06-88-552: Advanced Topics in MEMS
15.	Dr. Rashidzadeh	06-88-590-37: Advanced Analog Circuit Design
16.	Dr. Rashidzadeh	06-88-590-74: RF Integrated Circuit Design

17. Dr. M. Ahmadi — 06-88-525: 2-Dimensional Digital Signal Processing
18. Dr. M. Mirhassani — 06-88-590-47: Analog IC mask design

IX. COLLABORATIVE RESEARCH WITH THE PRIVATE SECTOR

IntellliSense Software Inc. 600 West Cummings Park, Suite 2000, Woburn, MA
Project: Collaborative research partnership. In-Kind support of $210,030 per annum
Principal Investigator: Dr. S. Chowdhury

OCE and Auto21

Auto21 initiated several technology transfer meetings during 2011 to transfer the developed technology to OEMs, Tier 1 automotive suppliers, and microelectronic companies including: Toyota North America, Fujitsu Tan, Magna Electronics, Invotronics, Escort Manufacturing.
Principal Investigator: Dr. S. Chowdhury

CMC Microsystems Corporation, 210A Carruthers Hall, Kingston, Ontario, Canada K7L 3N6
Principal Investigators: M.Ahmadi, C. Chen, W.C. Miller, .S. Chowdhury, . R. Muscedere, M. Khalid, Mitra Mirhassani, R. Rashidzadeh
Project: System-on-Chip (SoC) Design Methodology, Authoring IP Cores

Jean Monnet University, France

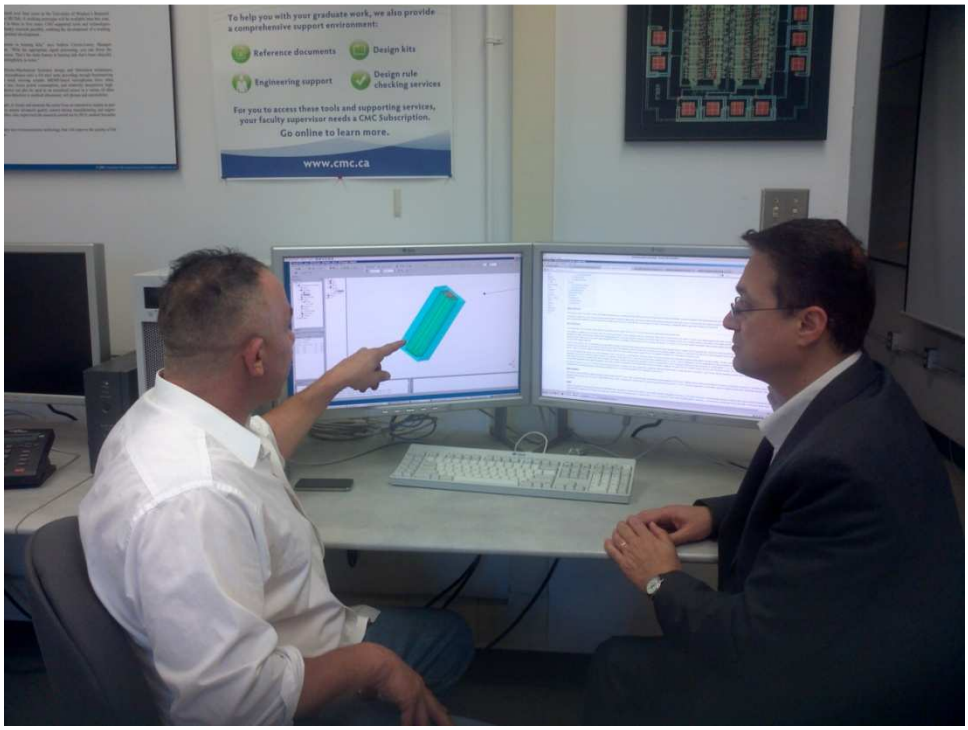
Dr. Ahmadi and Dr. Rashidzadeh were involved in co-supervision of students from Jean Monnet University. Dr. Khalid is working on joint research projects with faculty and researchers from Jean Monnet University in St. Etienne, France and Osmania University in Hyderabad, India.

I. PHOTOGRAPHS

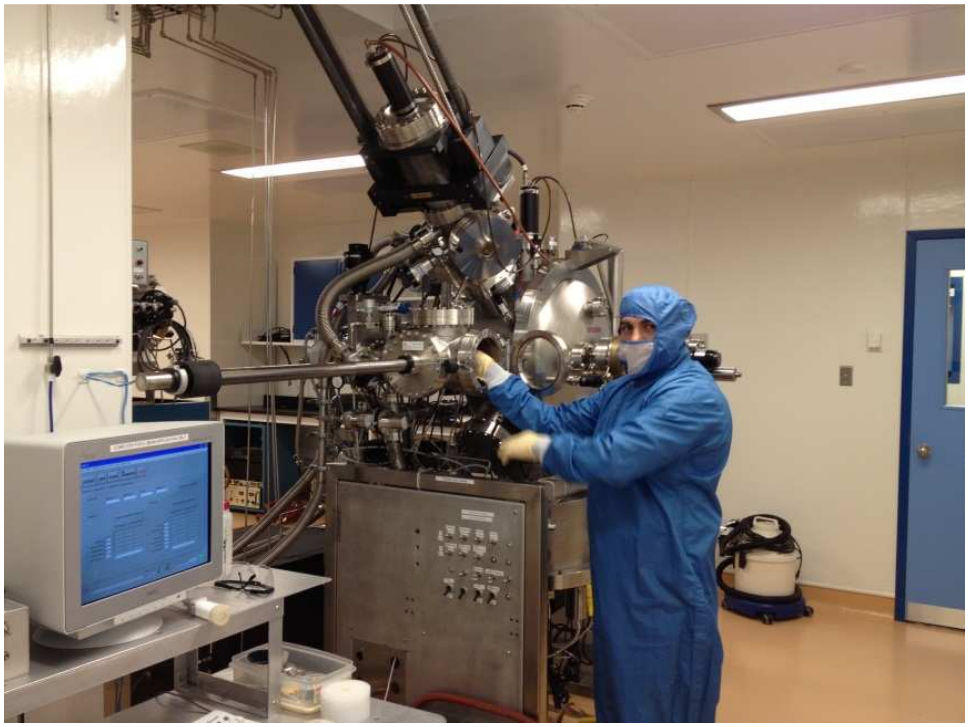
From left Dr. M.Ahmadi, Mr. Iftekhar Ibne Basith (MASc student), Dr. M. Saif (Dean of Engineering), and Ms Mahzad Azarmehr (PhD student)

From left, Mr. Amirhosein Nabatchian (PhD student), Dr. M.Ahmadi, Dr. M. Mirhassani, and Mrs Nabatchian

From left, Dr. Khalid, Dr. Ahmadi, Dr.Michael Orchard of Rice University (PhD external Examiner), Dr. Asfour (Chair of Defence), Dr. Boufama, Mr. Iman Makaremi (PhD candidate), and Dr. Wu



Mr. Nabeeh Kandalaft , Ph.D. candidate (left), and Dr. R. Rashidzadeh, RCIM manager, designing a MEMS test probe for 3D integrated circuits



Mr. Nabeeh Kandalaft, Ph.D. student, using clean room facility at the École Polytechnique de Montréal to fabricate a MEMS based test interface module

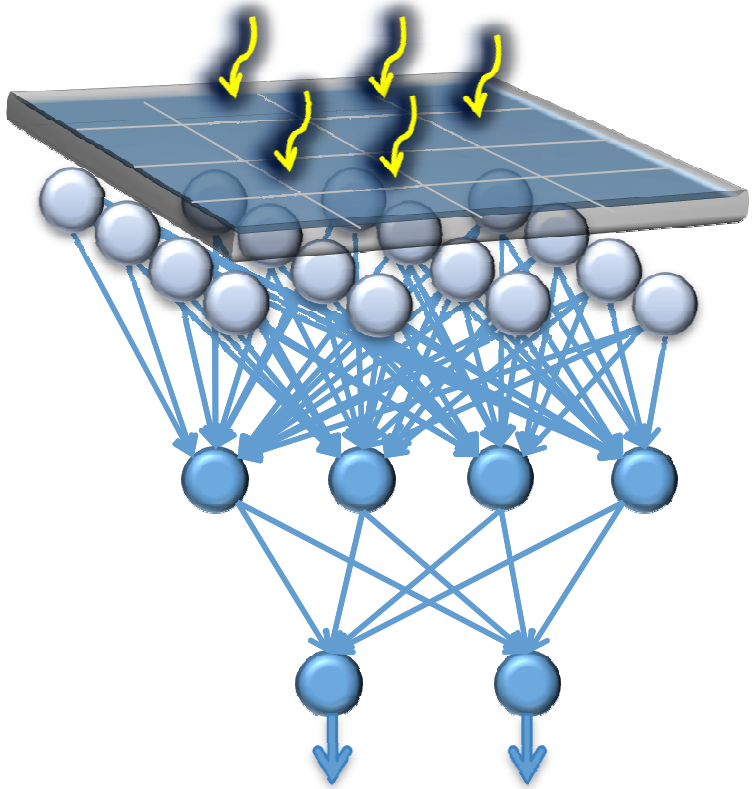
Dr. S. Erfani with faculty members from National University of Defence Technology in Changsha, China

RCIM faculty member, Dr. S. Erfani, presenting the results of his research at National University of Defense Technology (NUDT) in China

A Programmable Neural Network For General Pattern Classification Applications

Farinoush Saffar, PhD Student
Supervisors: Dr. M. Mirhassani, Dr. M. Ahmadi

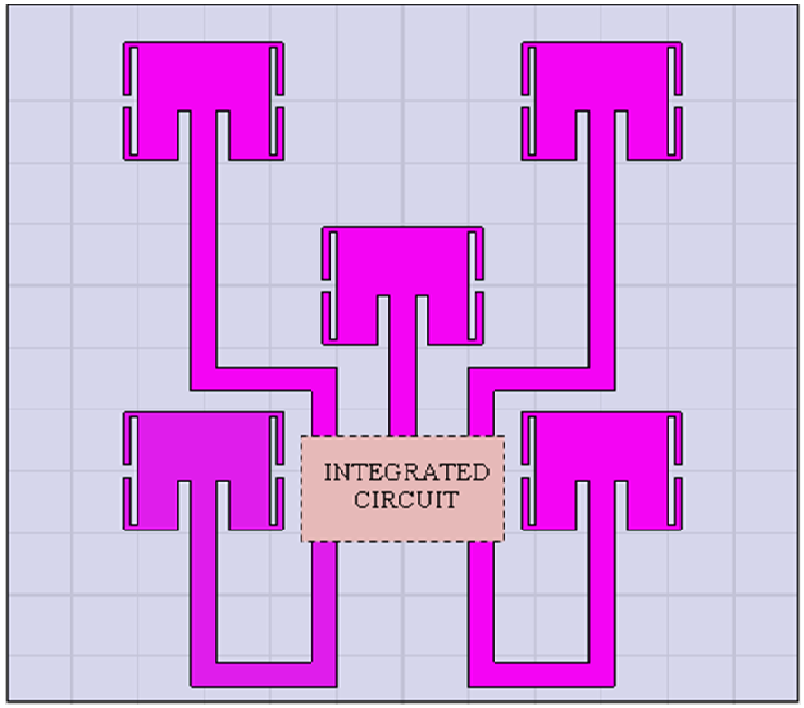
Artificial Neural Networks (ANN) are commonly used in applications where human brain may outperform conventional computers such as pattern classification. Significant number of synaptic weights and interconnections are considered as the main practical limitation on ANN hardware implementation. Using 2D optical input array instead of regular pins is one solution to have large number of input vectors without pin limitation or multiplexing delay. Additionally, using a time-multiplexed scheme for the neural network saves the die area and reduces routing complexity by lowering the number of interconnections. The neural network with these characteristics can be used in various applications such as handwritten numeral recognition.



A High Gain Scanning Patch Antenna for RFID Passive Tags Operating at 5.8 GHz frequency

Amar Sawadi, M.A.Sc. Student
Supervisors: Dr. R. Rashidzadeh, Dr. S. Erfani

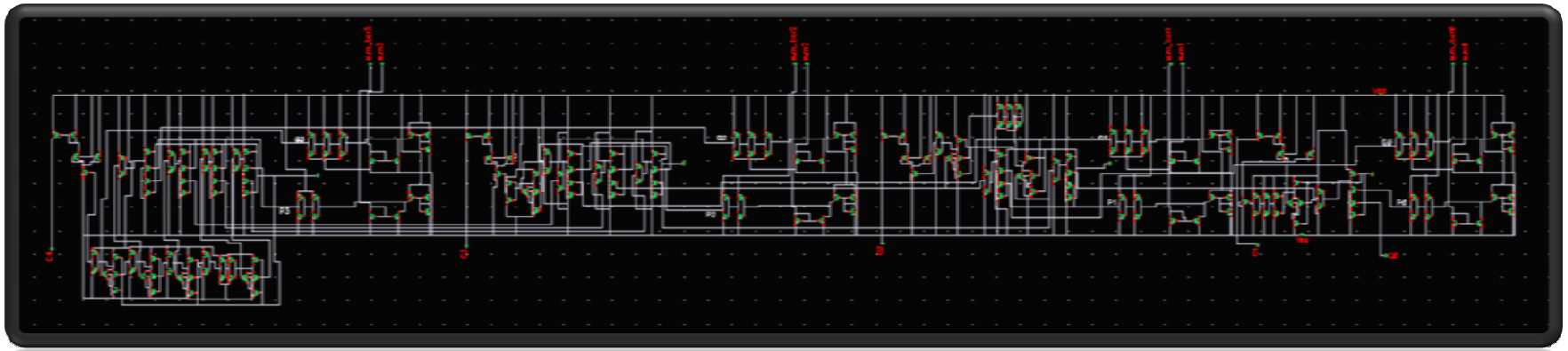
A new design for RFID passive tag antennas operating at super high frequency range is being designed. An array of four patch antennas has been employed to support higher gain and increase the communication range of a typical RFID passive tag. The direction of the antenna pattern can be controlled through phase shift of the input current. This adds a valuable scanning capability to the tag antenna allowing communication over longer distances. Simulation results using HFSS indicate that the proposed array antenna increase the gain by more than 7dB and adds the beam scanning capability which can be exploited to cover blind areas.



Multidimensional RFID antenna array

Mixed Signal Carry Look-Ahead Adder with Constant Power

Ashley Novak, M.A.Sc. Student
Supervisor: Dr. M. Mirhassani



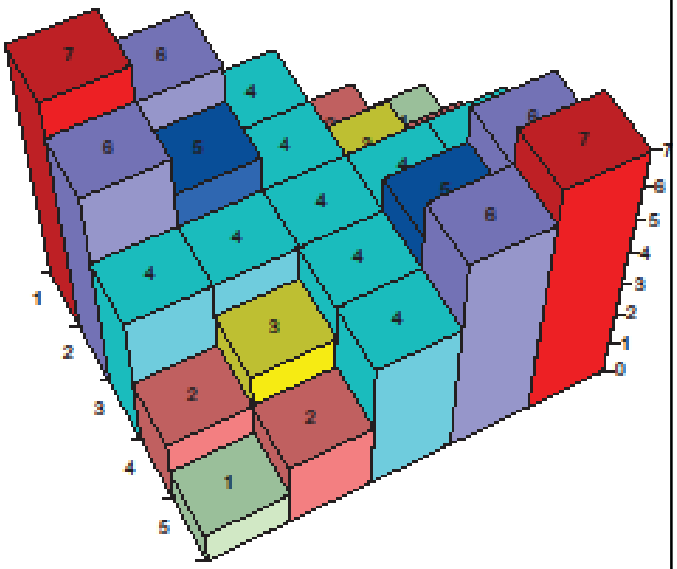
CLA Adder

Security is one of the paramount criteria when designing most electronic systems. The focus of this research is to design and develop a new type of adder to be used in cryptographic processors. By maintaining a constant power consumption profile, the possibility of side-channel attacks may be significantly reduced. These attacks pose a major threat to data security and demand new and innovative circuit architectures to be invented that may impede such breaches.

A 5-meter Range Non-Planar CMUT Array for Automotive Collision avoidance

Jonathan Hernandez, M.A.Sc. Student
Supervisor: Dr. S. Chowdhury

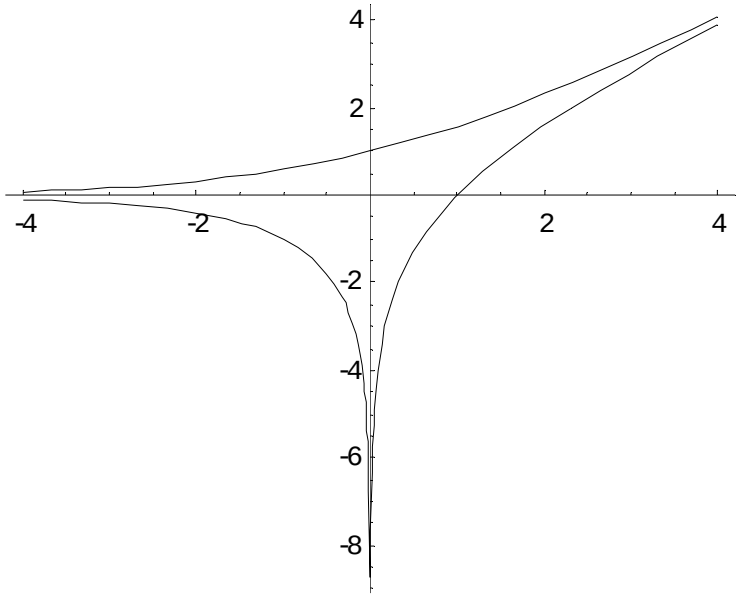
Collision avoidance systems (CAS) are security systems that help the driver to avoid or mitigate a collision, warning him that an impact may occur and automatically stop if the driver ignores the warnings. The performance of current vision based systems for blind spot monitoring such as side view mirror mounted cameras or lasers are compromised in bad weather. Current technology of electromagnetic radars is too expensive and they need a rotating platform to scan the target area. Ultrasonic sensors are good for short range proximity detection. An array of ultrasonic sensors can be used to form a directional acoustical beam focused at the blind spot of a vehicle. In this context, piezoelectric transducers have long dominated ultrasonic transducer technology, but capacitive micromachined ultrasound transducers (CMUTs) have recently emerged as an alternative offering advantages such as wide bandwidth, ease of fabricating large arrays, and potential for integration with supporting electronic circuits.



Improved MDLNS Number System Addition and Subtraction by Use of the Novel Co-Transformation

Leila Sepahi, M.A.Sc. Student
Supervisor: Dr. R.Muscedere

The Multi-Dimensional Logarithmic Number System is a generalization of the classical Logarithmic Number System (LNS). Unlike the LNS, there is no monotonic relationship between standard linear representations and MDLNS representations. Traditional lookup tables (LUTs) were used to perform addition and subtraction which are unrealistic for hardware implementations when large exponent ranges are used. We try to apply Novel Co-transformation which is the state of the art to eliminate LNS subtraction problem to the MDLNS addition and subtraction tables to increase efficiency of table sizes and accuracy.



Hardware JPEG Decompression

Dan MacDonald, M.A.Sc. Student
Supervisor: Dr. R. Muscedere

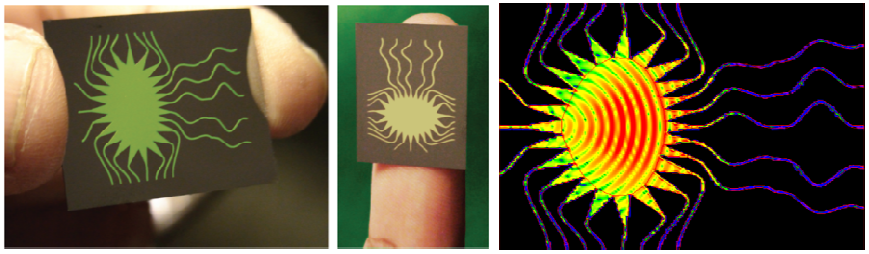
Evolution in digital photography has lead to large digital images above and beyond 20MP. Although handheld devices are becoming increasingly powerful, they are lacking the capability to view large JPEGs within a reasonable time frame.

The JPEG decompression process of a single 20MP image is extremely time consuming on a desktop computer, let alone a handheld device. This work presents integrating hardware components into the software JPEG decompression process to view an image in a fraction of the time.

A 77 GHz Rotman lens on a High Resistivity Silicon wafer for Automotive Radars

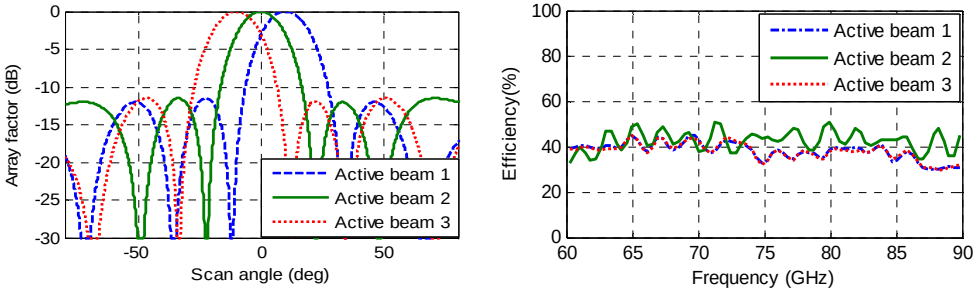
Ali Attaran, PhD Student
Supervisor: Dr. S. Chowhdury

A silicon based 77 GHz microstrip Rotman lens has been designed to develop a low cost small form factor MEMS based FMCW automotive radar sensor. The 19.7 mm x 15.6 mm footprint area lens realizes a passive beamforming and beamsteering capability to replace a significant amount of microelectronic circuitry as used in conventional automotive radars to realize the world's smallest form factor automotive radar. The lens has 3 beam ports, 5 array ports, and 16 dummy ports. The lens has been designed to have a bandwidth of 8 GHz centered at 77 GHz with less than 0.5 degrees maximum beam to array phase error. The lens exhibits excellent insertion loss, return loss, and isolation values.



(a) (b)

Fig. 1. (a) Rotman lens geometry, (b) Current propagation through the lens.



(a) (b)

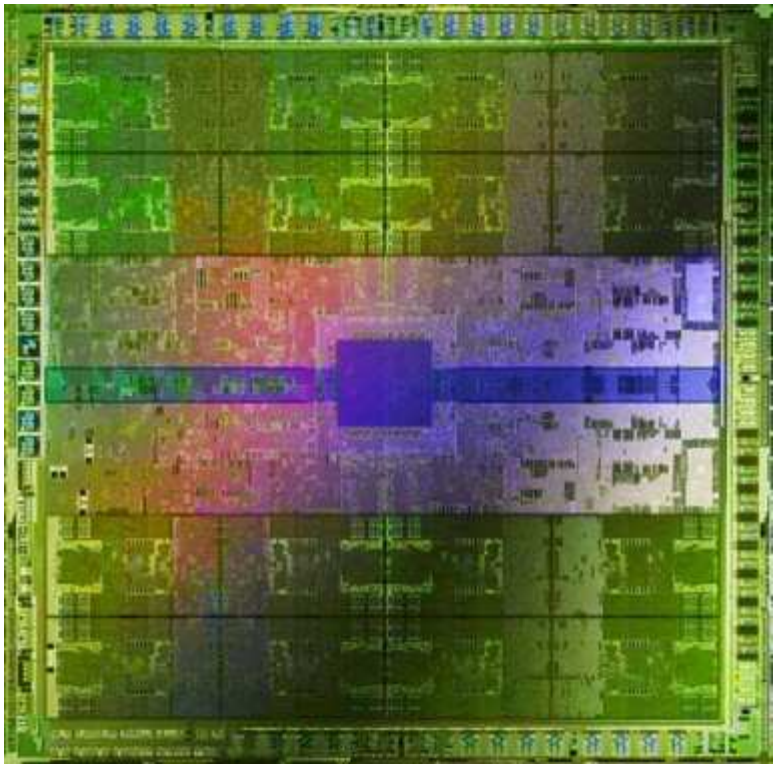
Fig. 2. (a) Array factor and (b) Power efficiency of the proposed Rotman lens for 3 beam ports.

GPU Acceleration of Elliptic Curve Cryptography

Karl Leboeuf, PhD Student
Supervisors: Dr. R. Muscedere, Dr. M. Ahmadi

Cryptography is an important part of our daily lives; it is used to secure communications over the internet whenever we use e-mail, Facebook, or on-line banking.

The goal of this project is to use relatively inexpensive graphics cards (GPUs) to carry out the elliptic curve operations, while reducing the load on the webserver. This has to potential to significantly reduce the number of servers needed to host on-line services, significantly lowering the overall cost to encrypt web traffic.

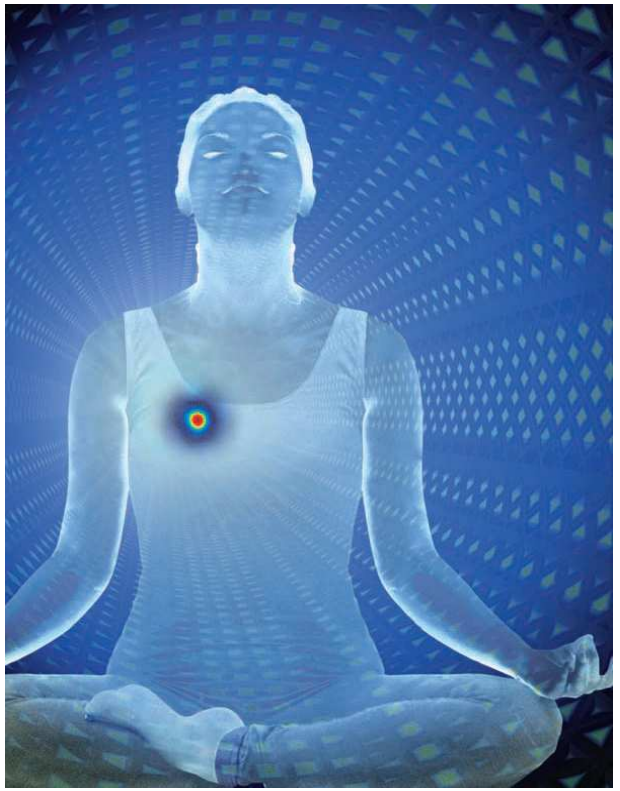


NVidia Fermi GPU

Microwave Imaging of the Breast for Early Cancer Detection

Jared Jacques, M.A.Sc. Student
Supervisor: Dr. S. Chowdhury

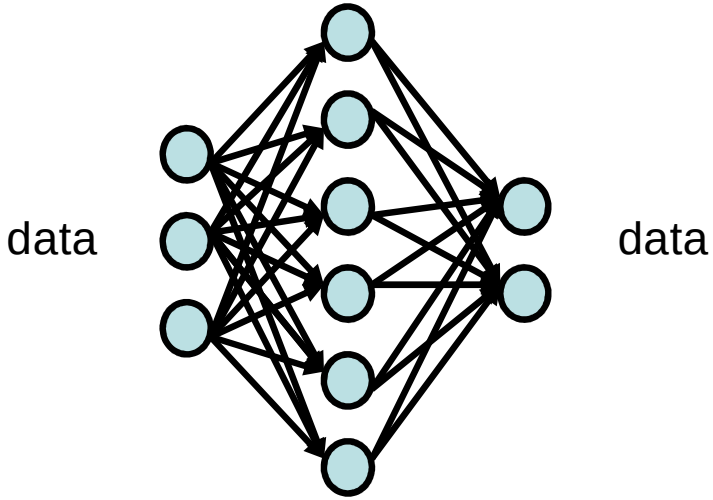
According to the Canadian Breast Cancer Association, 1 in 9 women will develop cancer in their lifetime and 1 in 29 will die from it. Currently, the best odds of successful treatment rely on early detection, with mammogram screening being the most effective detection method. With a high false negative rate (approx 20%) and a high false positive rate (up to 13%), mammography still leaves much to be desired and has therefore resulted in much research being devoted to finding an alternative detection method. In this work, MEMS technology is being applied to the antenna design in order to minimize costs and allow for a possible handheld design.



Design and Implementation of CVNS Based Artificial Neural Networks with On-Chip Learning

Babak Zamanlooy, PhD Student
Supervisor: Dr. M. Mirhassani

Neural networks have a better performance comparing to Von Neuman computers in the applications that are ill defined and need enormous amount of processing. An example is pattern recognition. Hardware implementation of neural networks is interesting when cost, speed and fault tolerance is considered. Achieving low Noise-to-Signal-Ratio (NSR) is one of the major concerns when implementing hardware-based neural networks. To improve the NSR, alternative arithmetic can be employed. The Continuous Valued Number System (CVNS) is a candidate for such application. A CVNS-based neural network with on-chip learning capability is going to be implemented. Circuit simulation and verification is done using Cadence Framework simulator and the fabrication will be done through CMC corporation.



Low Power Hardware Acceleration of Text Placement

Soheil Servati Beiragh, PhD Student
Supervisor: Dr. R. Muscedere

Computing power of hand held devices are limited by the amount of battery power they consume and the limited area. Most of the context shown on display of such devices is text. According to several different tests, the process of text layout is the most time consuming one for CPU. In our proposed method this task will be done in a small co-processor which consumes much less power than CPU and also gives us the choice to apply features like kerning to text for better readability. This will make the process faster and consumes less power.